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BUREAU OF PLANT INDUSTRY—Circular No. 123.

WILLIAM A. TAYLOR, Chief of Bureau.

MISCELLANEOUS PAPERS.

Factors Affecting the Production of Long-Staple Cotton . . . . . O. F. COOK

Behavior of Seed Cotton in Farm Storage . . . . . CHARLES J. BRAND and W. A. SHERMAN

Egyptian Cotton Culture in the Southwest . . . . . CARL S. SCOFIELD

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[Cir. 123—A]

FACTORS AFFECTING THE PRODUCTION OF LONG-STAPLE COTTON.[1]

By O. F. Cook, *Bionomist in Charge of Crop Acclimatization and Adaptation Investigations.*

INTRODUCTION.

The Department of Agriculture receives many requests for information and advice regarding the advisability of planting Egyptian and other types of long-staple cotton. The production of long staples has declined for several years because the boll weevil has invaded the former long-staple districts in the lower Mississippi Valley. The resulting scarcity and high prices have stimulated the production of long staples in other parts of the cotton belt, and planters are naturally inquiring how far this readjustment is likely to go.

The question can not be considered as purely agricultural, for the profits of a crop depend upon consumption and selling prices as well as upon the cost of production. More progress has been made in recent years on the agricultural side of the long-staple problem than on the industrial and commercial sides. There is no longer any doubt that the improvement of varieties and of cultural methods will make it possible to produce long-staple cotton more cheaply than in former years and over a much larger area of the cotton belt. In other words, it becomes apparent that the production of long-staple cotton is one of the undeveloped agricultural resources of the United States and one that is capable of enormous expansion. But it is equally apparent that anything like a full development of these resources must be accompanied by extensive changes and readjustments in the commercial and industrial world. Our manufacturers have been accustomed to deplore the limited and uncertain supplies of long-staple cotton. It now remains to be seen how long it will be before they take advantage of the removal of these limitations.

IMPROVED VARIETIES A FACTOR OF THE LONG-STAPLE PROBLEM.

A new factor is introduced into the problem of long-staple production by the early-maturing long-staple varieties that are now being distributed by the Department of Agriculture. The danger that the boll weevil would put an end to the culture of the old late-maturing long-staple varieties was foreseen nearly a decade ago and

[1] Issued Apr. 26, 1913.

investigations were begun to ascertain whether earlier varieties could be obtained. Three such varieties, Columbia, Foster, and Durango, have been developed and introduced to the public. If the necessary precautions are observed, the new varieties can be grown over a large part of the cotton belt. Instead of being excluded by the boll weevil there are reasons to indicate that the presence of this insect may make it more advantageous for the farmer to grow long staples.[1]

The time has come for a complete readjustment of opinions that were based on the old late-maturing varieties of long-staple cotton. The new early-maturing varieties can be grown much more widely and the staple can be produced more cheaply. In view of the results secured with the new varieties and the rapidity with which they are now being adopted there is no longer any doubt of the agricultural possibility of establishing a new long-staple industry; but so many factors are involved that no assurance can be given regarding the prospects of long-staple production in the immediate future. Too rapid an expansion of the industry may be expected to reduce prices and destroy profits. Yet these tendencies may be counteracted by increased demands for long-staple fiber. The use of long staples by manufacturers is likely to be stimulated by the prospect of a larger and more regular supply than could have been expected while the old late-maturing varieties were used as the basis of production. There is no possibility of knowing beforehand whether the supply and demand will keep pace with each other. The best that can be done under the circumstances is to point out some of the chief considerations that are likely to affect the long-staple situation in the next few years and leave the farmer to form his own judgment regarding the advisability of planting long-staple cotton in his own district.

PRODUCTIVENESS OF EARLY LONG-STAPLE VARIETIES.

There is a general impression that long-staple varieties are necessarily less productive than short-staple varieties. Many planters have held this idea so long that they now regard it as an absolute principle and find it very difficult to entertain even a doubt on the subject. The impression is based on experience with the old late-maturing small-bolled varieties of long-staple cotton, which required a very long season to ripen a full crop. In reality, there is nothing to show that early long-staple varieties are less productive than short-staple varieties with similar habits of growth.

There is often no advantage in the form of earliness that is represented by the date when the bolls begin to open, for this early opening is a characteristic of short-staple varieties with very small bolls.

[1] Cook, O. F. Cotton improvement under weevil conditions, U. S. Department of Agriculture, Farmers' Bulletin 501, 1912.

The form of earliness that is of practical importance as a means of avoiding weevil injury is represented by the setting of the crop in the shortest period of time after flowering begins.[1] There is no reason to believe that the new long-staple varieties are deficient in this form of earliness. Indeed, they have outyielded short-staple varieties in many experiments.

The fact that the new long-staple varieties are early and productive and can be grown under a wider range of conditions means that planters of these varieties take fewer chances of loss than with the old late-maturing long-staple varieties. Wide fluctuations in the prices made the planting of long-staple varieties more of a speculation than the planting of short staples and tended greatly to discourage long-staple production. Though long-staple planters might in some seasons make more than neighbors who planted short staples there were other seasons when the long staples were much less profitable than the short. But it is difficult to see how the planter of early productive long-staple varieties can be placed at any serious disadvantage with his neighbors. The worst that is likely to happen is not to be able to sell the long-staple crop for what it is really worth in comparison with short-staple cotton.

MARKETING, A COMMUNITY PROBLEM.

The marketing problem has to be solved before the farmer can be assured of the full value of his cotton, whether long staple or short. There is always somebody at hand to buy short cotton at somewhere near regular market prices, but only a few buyers, comparatively speaking, have the skill that is required to deal fairly in long-staple cotton. The average buyer, if he handles long staples at all, is afraid to pay full prices, for fear that his estimate of quality may be wrong. Of the buyers who know the value of the cotton, many do not feel called upon to inform the farmer, it being their idea of business to buy as cheaply as possible. The greater difficulty of marketing long-staple cotton to a proper advantage is one of the reasons why growers have been advised to organize themselves on a community basis.[2]

SPECIAL REQUIREMENTS OF LONG-STAPLE PRODUCTION.

With early long-staple varieties as productive and as easy to grow as short-staple varieties there might appear to be no reason why higher prices should be paid for long staples than for short. But if the buyers or manufacturers were to act on this assumption they would defeat their own interests. The intrinsic value of the long

[1] Cook, O. F. Relation of drought to weevil resistance in cotton, U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 220, 1911.

[2] Cook, O. F. Cotton improvement on a community basis. Yearbook, U. S. Department of Agriculture, for 1911, p. 397–410.

staple is higher because finer, stronger, and more durable articles can be made from the long staples than from short. The farmer should receive his share of the advantage, even if it were as easy to maintain the production of long staples as of short staples. But in reality this is far from being the case. Long-staple cotton requires not only more favorable natural conditions but greater intelligence and skill on the part of the farmer. If the ability needed in this branch of agriculture is not properly remunerated it will not be enlisted.

If a new long-staple industry is established, it must be on a very different basis from the present short-staple industry. The results for the first season or two with a new variety in a new district are likely to be entirely deceptive. Unless special attention is given to the problem of maintaining stocks of pure seed by continued selection, the crop is sure to decline in quality as well as in quantity. With the usual neglect of selection, crossing of varieties in the field, and admixture of seed at public gins, the uniformity of an improved stock is usually lost before it has been out of the breeder's hands for more than two or three years. Degeneration becomes apparent in long-staple varieties sooner than in short staples, because the requirement of uniformity is higher. Spinners can not use mixtures of long and short cotton, so that bales representing a mixture of long and short varieties have less value than the same amount of short cotton alone. It is a mistake to suppose that a successful long-staple industry can be maintained by the ordinary methods of cotton farming.

As yet there are very few farmers who appreciate the importance of preventing admixture of seed of different varieties at the gin or crossing in the field. While improvements in this direction may be expected, the change is likely to be very gradual and to become effective only in communities that specialize on the production of a single superior variety of cotton. If the uniformity of superior stocks is preserved, the seed can usually be sold at a higher price, as well as the fiber. Community organization is as necessary for maintaining pure stocks of seed as for marketing the crop to best advantage. Any effective encouragement of long-staple production by commercial or manufacturing interests is likely to come about through cooperation with organized communities of farmers who will limit themselves to a single superior variety of cotton. Desultory plantings of long staples by scattered individual farmers are likely to produce only a precarious supply, irregular alike in quality and quantity. Improved methods have been developed which simplify the work of selection and render it more effective, but all such work must have a basis of thorough familiarity with the variety.[1]

[1] Cook, O. F. Cotton selection on the farm by the characters of the stalks, leaves, and bolls. U. S. Department of Agriculture, Bureau of Plant Industry, Circular 66, 1910.

PREMIUMS FOR LONG-STAPLE COTTON.

Notwithstanding their greater utility the new early-maturing long-staple varieties can not be expected to place the long-staple industry on the same basis as the short-staple industry, and this would not be desirable. The greater care that is necessary in maintaining long-staple varieties, as well as in growing, handling, and marketing the crop, must be compensated by a higher price for the product or the precautions will not be observed. The more careful and intelligent planters will not continue the cultivation of long-staple cotton and permanent long-staple communities will not be established.

Nevertheless, the difference in prices between long and short staples need not be as large as was necessary formerly, when only the old late-maturing varieties were available. Figures furnished by an association of New England manufacturers, covering a period of years, showed that the cost of their supplies of long-staple cotton had been about 60 per cent higher than the prices paid for corresponding grades of short staples. With the earlier and more productive long-staple varieties that are now available, smaller premiums, perhaps not more than 30 per cent on the average, may be sufficient to develop and maintain a long-staple industry. No doubt the actual prices will continue to fluctuate with the seasons in accordance with the general relations of supply and demand, but unless a fair average is maintained the industry will not attract the participation of the best class of farmers.

PROSPECTS OF LARGER DEMANDS FOR LONG STAPLES.

If the commercial conditions that determine the demand for long-staple cotton remain the same in the future as in the past only a limited utilization of the new varieties is to be expected. With a strictly limited demand a condition of overproduction must be soon reached, prices will decline, farmers will be disappointed, and many of them will go back to short-staple varieties. But in reality the demand for long staples is not strictly limited. It is rather the limited and uncertain supply that has restricted the use of long staples. There is every reason to expect a greatly increased consumption if long staples can be supplied more regularly and cheaply, and this is made possible by the new early-maturing varieties. Of course, too rapid expansion of long-staple production may cause a slump in prices, but a cheap and abundant supply would have the indirect advantage of encouraging use and thus tending to establish a larger permanent demand.

Increased demands for long staples are to be expected on account of their industrial superiority over short staples. Short-staple cotton is only poorly adapted for many of the purposes for which it is now

used. Improvements in machinery have made it possible to spin shorter and shorter fibers, but the resulting fabrics are weaker and less durable. From a general economic standpoint a large part of the labor expended in producing inferior cotton and manufacturing inferior fabrics appears to be wasted, to say nothing of the loss imposed on the consuming public.

In view of the great amount of attention that the problem of the increased cost of living is now receiving in all quarters it does not seem reasonable to believe that the immense economic waste involved in the production and manufacture of inferior cotton will be left out of consideration much longer. Some of the States have laws to protect the public against textile adulterations as well as against adulterations of food, and the various suggestions for pure-clothes laws are rapidly taking more definite form. There is even more reason why the public should protect itself against inferior fiber in cotton fabrics than against cotton mixed with wool or silk, where the deception is much more easily detected.

While there are many legitimate uses for short, inferior fiber, there are also many illegitimate uses, that is, uses not to the advantage of the consuming public, however profitable they may be to the manufacturer and dealer. In the presence of productive, early-maturing long-staple varieties there is no longer any valid agricultural reason for this wasteful substitution of inferior short staples for industrial purposes that would be better served by the use of long staples. But the mechanical and commercial reasons remain, and these will continue effective as long as profits can be made from the manufacture and sale of weak, short-lived fabrics to an undiscriminating public.

When the importance of these factors is once appreciated, remedial measures are not likely to be delayed very long. A large measure of protection would be obtained by a simple requirement that the public be informed regarding the length of the fiber used in textile articles. A regulation of this kind would be easy of enforcement, for the length of cotton fibers is readily determined with improved appliances that are now available. Even though no standard of strength were prescribed, the danger of deception on this side would be relatively small, for manufacturers would hardly find it worth while to make a specialty of collecting supplies of weak long-staple fiber, which would also be more difficult to spin and weave into fine, well-finished fabrics.

With any approximation to equality in the cost of production the long staples can compete readily with the short staples. The short staples have been used because there seemed to be no prospect of securing adequate and regular supplies of long staples and in spite of the well-known inferiority of the short staples. But now the question is to change back toward the use of long staples. The

difficulties and uncertainties of the present situation lie in the readjustments that must be made in placing the cotton industry on a more honest and substantial basis, and thus open the way to a better development of our resources of production. The competition that is rapidly springing up in many foreign countries is likely to force these changes in time, if they are not accomplished voluntarily in the interest of American agriculture and of our own consuming public.

CONCLUSIONS.

The improved varieties of long-staple Upland cotton developed and distributed by the Department of Agriculture introduce a new factor into the problem of production. On account of their early-maturing habits these long-staple varieties often yield as much as short-staple varieties, and they are adapted to cultivation in many parts of the cotton belt where the old late-maturing varieties could not be grown to advantage.

Too rapid adoption of the new varieties will result, no doubt, in overproduction and a decline in prices of long staples. But, on the other hand, there is reason to expect a large increase in the demand for long staples, which are better adapted to many industrial purposes than the short staples that are now being used. The prospect of a larger and more regular supply of long-staple cotton is likely to lead to more extensive use and tend to more stable commercial conditions, thus permitting a gradual development of the new long-staple industry.

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[Cir. 123—B]

BEHAVIOR OF SEED COTTON IN FARM STORAGE.[1]

By Charles J. Brand, *Physiologist in Charge*, and W. A. Sherman, *Scientific Assistant, Farmers' Cooperative Cotton Handling and Marketing.*

INTRODUCTION.

The question of storing or bulking cotton in the seed for a time before ginning is one in which considerable interest has developed. Ginners, spinners in the cotton belt, and others have claimed that many desirable results would follow from a general practice of storing seed cotton for a period of two to five weeks before ginning. They have also emphasized the probable benefits of "sweating out" and aging, and called attention to savings that might result, such as reduction in loss of time of men and teams from standing at the gin awaiting their turn, increased output of lint per gin stand, and many other benefits. Apparently very few definite experiments along this line have been conducted, and, so far as the writers know, none have been described either in the cotton journals or in the publications of agricultural colleges and experiment stations.

In order to determine somewhat accurately the behavior of unginned cotton picked at various times and under varying conditions, a cooperative arrangement was made with Mr. E. W. Evans, of Bennettsville, S. C., during the picking season of 1912.[2] Mr. Evans had slightly reconstructed one of his farm buildings for use in aging or storing his staple cotton prior to ginning. The dimensions of this buildings are 30 by 60 feet, and the ground floor had been divided by complete partitions into four compartments or bins, each 15 by 30 feet. The arrangement of these bins can be seen in figure 1.

The well-floored loft above the storage bins was left without partitions of any kind and the cotton pickings of each day were placed in the loft, spread generally over the floor to an average depth of 18 inches. The purpose of this procedure was to give the various pickings an opportunity to dry out to a moderate degree before they were finally bulked and forked through the trapdoor into one of the bins below. The building has a double wall, being sided with ordinary

[1] Issued Apr. 26, 1913.

[2] All temperature and moisture observations were made by Mr. Chester A. Kotterman, formerly laboratory aid in the Office of Farmers' Cooperative Cotton Handling and Marketing, who was stationed at Bennettsville, S. C., during the greater part of the cotton-picking season.

weatherboarding and lined with matched lumber. The inner partitions were also of matched material, but of one thickness only.

A ventilator about 2 feet long by 10 inches in width, covered with fine wire screen, was placed in the outer wall of the building next to the ceiling of each bin, and the communicating doorways between bins were kept open most of the time, thus affording a limited circulation of air above the stored cotton.

On September 30, when the final arrangements for the work had been completed, bin A contained a fairly large bulk of seed cotton weighing about 10,000 pounds, composed of early pickings. On October 1 this cotton was removed to bin B, and the first lot of cotton to be used throughout the storage season was forked from the loft into bin A below. Arrangements were immediately made for placing this bulk on a definite floor space, burying in it at selected depths and in different parts 10 electrical thermometer bulbs with leads of suitable length for attaching in the aisle outside to a regular balance indicator with galvanometer. This cotton had been picked on September 25 and had remained in the loft one week. It weighed 5,800 pounds and when thoroughly tramped had a density of about 12.3 pounds per cubic foot in the pile. The average depth of the cotton as finally left for the experiment was 3.5 feet. This body of cotton is designated as pile 1 in figure 1.

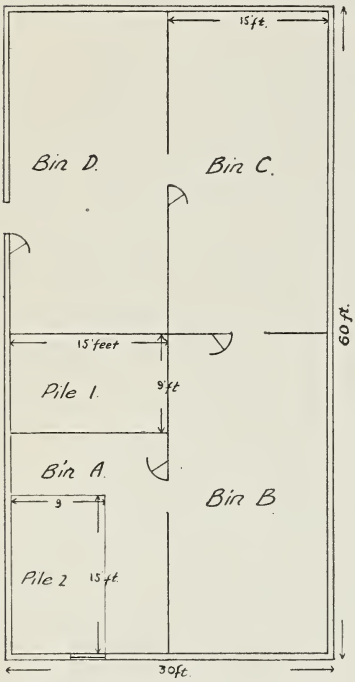

FIG. 1.—Floor plan of storage house, showing the size and location of bins and the space occupied by the cotton under observation.

On October 2, for purposes of comparison, a freshly picked lot of cotton weighing 6,180 pounds was placed in bin A, shown in figure 1 as pile 2, to be used in comparing the behavior of freshly picked cotton without a preliminary loft drying with cotton that had been allowed a week in which to dry out. The second lot of cotton was left without tramping and made a pile of an average depth of 4.5 feet, having been so placed as to occupy the same number of square feet of floor space as pile 1. This pile of cotton had a density per cubic foot of 10.1 pounds and represented the pickings of October 2 which had been left out in the warm sun throughout the day and then placed in the bin in the evening directly after being

weighed. The appearance of these piles of cotton is shown in figure 2. The mass at the left is the untramped cotton. The tramped pile is shown in part at the back. The leads from the thermometer bulbs may be seen here and there on the face of the cotton.

TEMPERATURE IN UNGINNED COTTON STORED UNDER VARYING CONDITIONS.

The records of temperature shown in Table I apply to both piles of cotton, the tramped and the untramped. The bulb buried in pile 1 at point 1 compares most directly with the one buried in pile 2 at

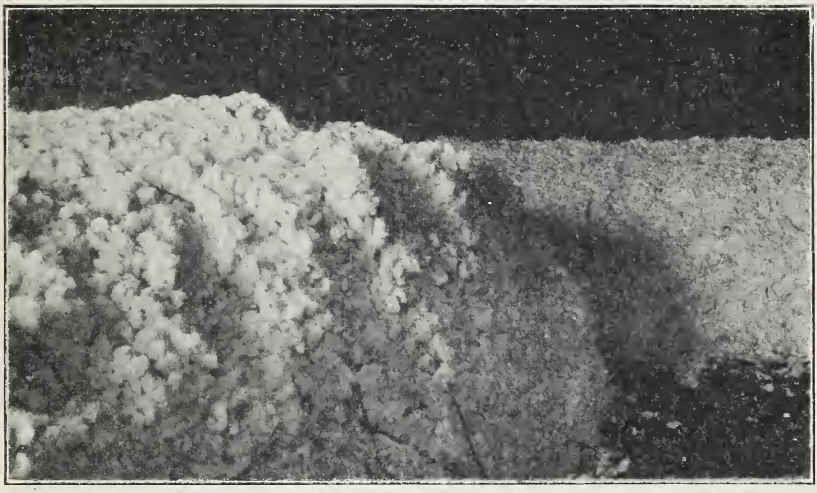

FIG. 2.—Two piles of experimental cotton in bin A. The one at the left has not been compacted in any way; the other was thoroughly tramped.

1′, 2 with 2′, and 3 with 3′. All were buried about midway of the total depth of the respective lots of cotton, well removed from immediate effects of room and outside temperatures and humidities. The conditions that prevailed in the middle of each pile are represented by 2 and 2′.

The temperatures and humidities from October 5 to November 17, shown in the table, are the average of three daily observations taken at 7 a. m., 12.30 p. m., and 6 p. m.

TABLE I.—*Average daily temperatures in tramped and untramped seed cotton and average daily temperature (°F.) and relative humidity outdoors and in storage bin, October 5 to November 17, 1912.*

Date (1912).	Temperature (° F.) in tramped (1, 2, 3) and untramped (1′, 2′, 3′) piles.						Outside.		Inside.	
	First bulb pair.		Second bulb pair.		Third bulb pair.		Temperature.	Relative humidity.	Temperature.	Relative humidity.
	1	1′	2	2′	3	3′				
October—										
5	69.3	83.1	69	82.8	68.5	80.4	76	55	75	58
6	69.4	81.5	69.8	81.3	68.8	79.3	74	50	76	44
7	70.7	78.6	70.8	79.9	70.9	77.9	76	44	74	58
8	70.8	72.8	71.3	79.3	71.3	77.9	69	63	69	63
9	71.7	67.6	71.9	77.7	70.6	75.6	65	61	66	53
10	71.3	68.5	71.7	76.8	70.3	73.6	71	68	71	72
11	72.7	72	72.2	76.4	71.3	73.9	74	74	75	74
12	73	72.3	72.6	75.9	72.3	74.5	75	70	74	74
13	73.9	73.2	73.7	74.7	72.8	74.1	75	74	75	78
14	74.5	69.2	74.8	75.9	73.5	73.9	57	82	57	88
15	74.6	64.5	74.6	74.2	71.7	71.8	63	69	63	69
16	73.8	62.8	73.8	73.3	70.5	70.7	60	63	60	63
17	72.5	60.4	72.2	71.6	68.8	68.7	57	71	57	66
18	70.9	60.6	70.9	70.1	66.4	67.4	63	79	63	74
19	69.9	65.3	70.4	68.9	66.8	66.8	68	90	68	90
20	70.2	67.6	70.3	69	67.6	67.4	66	71	66	71
21	70.2	64.2	70.3	69.2	67.7	67.1	60	89	61	89
22	70.1	66	70.1	68.1	67.6	66.3	68	95	69	90
23	69.5	67.3	70.1	68.3	67.6	67.2	65	66	65	70
24	69.7	58.8	70.2	67.9	67.3	65.8	53	52	53	63
25	67.6	55.5	67.8	66.6	65	64.2	57	45	55	65
26	66	56.7	66.7	65.5	63.5	63.2	57	61	57	61
27	65.5	55.6	66	64.9	62.8	62.5	57	50	58	46
28	63.7	53.7	64.7	64	61.3	61.4	54	53	53	58
29	62.8	55.1	63.2	62.5	60	60.4	57	61	56	55
30	61.5	57.1	62	61.9	60	60.2	62	69	63	69
31	61.2	59.6	61.9	61.3	60.3	60.6	61	68	63	69
November—										
1	61.8	63.1	62.8	61.7	61.4	61.5	68	90	68	85
2	62.8	60.4	62.6	62.1	62.3	62.1	50	55	53	58
3	62.3	50.3	62.8	61.3	59.8	59.6	42	62	43	55
4	60	46.7	61.3	58.8	57	57.1	47	53	46	58
5	58.9	48.8	59	57.6	56.1	55.9	51	56	52	63
6	57	57.6	57.9	57.3	56.6	56.1	65	85	65	85
7	58.3	65	58.5	58.8	58.5	58.7	68	90	69	81
8	59.9	61.6	59.9	59	60.6	60	57	61	59	62
9	60.7	58.5	61.1	59.1	59.4	60	46	65	49	61
10	60.3	53.8	60.4	58.4	58.9	58.1	49	61	51	56
11	59.6	52.6	59.6	57.4	58.5	57.4	53	58	53	58
12	58.9	55.9	58.9	59.9	58.3	57.9	58	61	59	62
13	59.6	60.9	59.6	58.4	59.4	59	62	74	64	74
14	59.8	59.4	59.8	59	60.4	60.1	60	68	63	64
15	60.3	53.1	60.3	57.6	60.5	58.1	42	47	46	65
16	59.8	48.6	59.8	57.3	57.6	56.7	42	62	43	63
17	57.8	45.9	57.8	55.5	54.9	54.5	35	72	39	67

The fluctuations in temperature in both tramped and untramped cotton were so slight that it is evident that practically no heating took place. Bulbs 1, 2, and 3 were in tramped cotton, pile 1. Bulb 1 reached its maximum temperature, 74.6° F., on October 15, 10 days after the cotton was placed in the pile, a rise of only 5.3 degrees. From this date there was a gradual subsidence except during the last 10 days, when there were slight fluctuations, the total decline amount-

ing to about 15 degrees from the maximum. The course of bulb 2 very closely agrees with that of bulb 1, while bulb 3 averages slightly lower throughout.

Bulbs 1′, 2′, and 3′ occupied nearly corresponding positions in the untramped cotton, pile 2. Each of these started in with a higher temperature than the other pile developed at any time. It should be remembered that the cotton in pile 1 had been spread in the loft a week, while pile 2 was composed of cotton brought directly from the field, which had retained considerable warmth received directly from the sun. This accounts for the high initial temperatures in the second pile. These bulbs showed a fairly uniform decline, except in the case of bulb 1′, where there was a rise of 10 degrees from October 28 to November 1, followed by a decline of over 16 degrees to November 4 and another rise of 18 degrees by November 7. This bulb was located in the most compact part of the loose pile, and the fluctuations may be due to slight heating in spots, because sheets containing cotton picked in the morning carried more moisture than those picked in the afternoon. Correspondingly sharp changes were not noted in the temperatures recorded from bulbs 2′ and 3′. A bulb giving readings not shown in the table placed on the floor under the center of pile 1 agreed closely with the outdoor temperature. This indicates that such temperatures as were developed were not communicated downward in such a way as to affect the layer of cotton immediately on the floor. The building is on blocks, allowing free circulation of air under it.

The temperatures outside and inside the building show no marked difference in fluctuations and no correlation with temperatures generated within any of the piles. The same may be said regarding the relative humidities, which have been included chiefly because of their interest as showing the atmospheric moisture conditions that prevailed during a large part of a single cotton-picking season.

MOISTURE CONDITIONS IN UNGINNED COTTON IN FARM STORAGE.

On October 1, when possession was taken of bin A, the cotton then in it was moved to bin B (fig. 1). On October 15 this cotton was moved again to bin C. Two thermometer bulbs had been placed in the pile when it reached bin B. The temperatures indicated by these gradually rose from October 1 to October 15. On the first date these bulbs, which were buried in the pile at different places, but both 18 inches deep, showed temperatures of 69° and 70° F., respectively; on October 7, 74° and 72° F.; and on October 14, 82° and 80° F. On October 15 the still rising temperature was interrupted by forking into bin C.

On October 10 samples were taken at four points in this pile of cotton for the determination of moisture. Two of these were drawn

from the cotton around the bulbs, which were 5 feet apart, and two from other places in the inner part of the pile. The variation in moisture content was found to be inconsiderable, the four points sampled showing the following percentages: 14.04, 14.88, 14.71, and 14.46.

To avoid loss of moisture, tightly covered tins, such as are used in making soil-moisture determinations, were employed for taking samples, and the moisture was determined immediately. A small type of single-wall, heavy copper drying oven was used in this work.

On October 15 the cotton in this pile was sampled again, two composite samples being taken from the deeper portions and two composite samples from the outside of the pile. The former showed a moisture content of 14.72 and 14.38 per cent, respectively, while the two from the outside contained 11.88 and 11.07 per cent. These figures indicate that there is a fairly uniform diffusion of moisture through a large body of cotton. It will be remembered that this bulk contained about 10,000 pounds.

At the time of sampling, on October 15, the cotton inside the pile felt warm to the touch. On October 1, before this cotton had been moved from bin A to bin B, thermometer bulbs that had been buried in it showed temperatures as high as 111° F. in spots. When moved to bin B it cooled off considerably, but remained between 70° and 80° F. That the moisture conditions in these lots of cotton were not unusual is shown by a comparison with the conditions that prevailed in piles 1 and 2 in bin A. On October 8 the surface cotton in both of these piles showed a moisture content of 11.95 per cent, there being no difference between the tramped and untramped cotton. The cotton at the center of the pile showed a moisture content of 14.45 per cent for the tramped cotton and 14.06 per cent for the untramped cotton.

On November 25 moisture determinations were made again on piles 1 and 2, which had then been in storage for nearly seven weeks, the former having passed through a week of preliminary drying, while the latter was placed directly in the storage bin. The surface cotton of the tramped pile contained 9.1 per cent of moisture, while the surface cotton of the untramped pile contained 9.4 per cent. The deeper cotton within the tramped pile had a moisture content of 13.7 per cent, while that similarly located within the untramped pile had 12.05 per cent, possibly indicating the more ready loss of moisture from the looser cotton, which would be expected.

Moisture determinations were made again on this cotton on the day when it was ginned. Both the surface and interior cotton of the untramped lot had lost more moisture than the tramped lot. The interior cotton of the latter maintained a moisture content of 13.4

per cent, while the interior of the looser and untramped contained 10 per cent. The surface cotton of the two piles by this date, December 1, had run down to 8.7 per cent on the tramped and 8.8 per cent of moisture on the untramped pile. As far as can be observed, there were no correlations between moisture and temperature in these two lots of cotton.

A bale of the staple, which is about 1¼ inches long, from the tramped pile was purchased for spinning and waste comparisons with freshly picked and immediately ginned cotton of the same variety, namely, Webber, and with another bale ginned from a body of 40,000 pounds of seed cotton of the same variety which had been stored unginned for a considerable period in bin C.

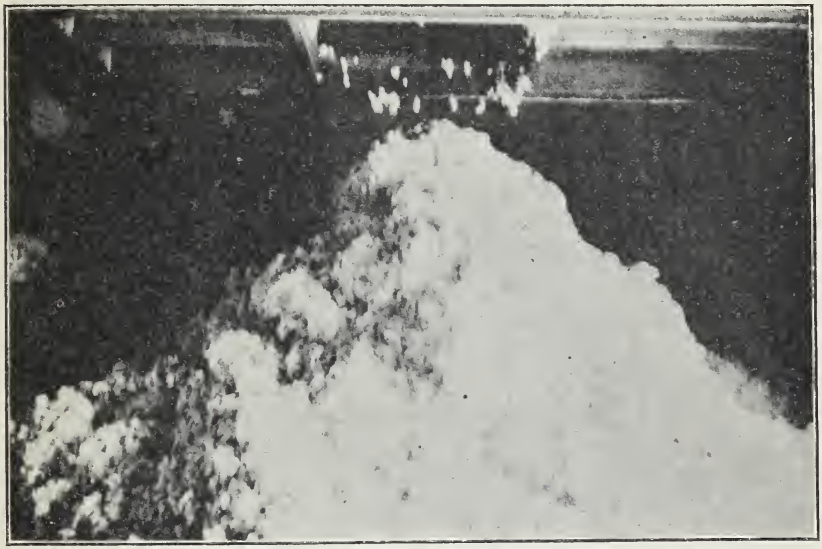

FIG. 3.—Pile containing about 30,000 pounds of seed cotton. This cotton was picked through a period of several weeks and did not suffer from heating.

Bins C and D ultimately contained between 70,000 and 80,000 pounds of seed cotton. This was accumulated gradually, the cotton at the bottom having received the preliminary drying in the loft, while the later pickings were added to the pile daily, unless rains occurred which made it advisable to dry the early morning pickings of certain days before adding them to the pile. It was found that practically all of the later pickings, if dry when picked, could be thrown into the bulk without any danger of heating.

About the middle of November, when the pile in bin C had attained a weight of about 30,000 pounds, two composite samples were taken from both the inside and the outside of the pile. The pile of cotton as it appeared at this time is shown in figure 3.

The moisture content of the surface cotton was 10.86 per cent in one sample and 10.4 per cent in the other, while the two inner samples showed a moisture content of 10.26 and 10.85 per cent, respectively. It is not surprising that this lack of variation in moisture between the surface and the deeper cotton should occur, as compared with the other piles in which moisture determinations were made. The pile was built up gradually. The warm, dry cotton which had remained in the sun each day until evening in the pickers' sheets had had ample opportunity to dry out and went to the storage house in this condition.

THE EFFECT ON SEED GERMINATION OF TEMPERATURES DEVELOPED DURING STORAGE.

The germination of cotton seed is proverbially poor under the usual conditions of handling and storage, and this accounts in a large measure for the habitual use of about four times the quantity of seed needed for a stand. In the days when most of the surplus was composted for manure on the plantation, it was well understood that only a little fermentation and heating need take place to prevent any trouble from the germination of the seed so used.

Our temperature observations at Bennettsville afforded opportunity for only a partial confirmation of this belief, but germination tests on seed from three lots having different temperature records were made by the Seed Laboratory of the Bureau of Plant Industry, as follows:

The first was from a composite sample of seed cotton taken from the surface of pile 1 in bin A, previously described, about a week after picking, the cotton having been spread on a loft floor meantime and subjected to no heating nor to any effect resulting from bulking. The weather from the time of the opening of the first bolls until picking had not been such as to cause any evident damage, and the weather during the last week in September when the cotton was picked was dry and in every way favorable. The sample was kept in a perfectly dry room, brought to Washington at the close of the Bennettsville work, and several hundred seeds were hand ginned for the test. The first test showed a germination of 43.5 per cent in seven days; a retest showed 64 per cent. There was some anthracnose in evidence in this field, but so far as known no other apparent reason for the low percentage of germination.

The second test was of seed taken from an earlier picking from the same field, there being about 10,000 pounds of seed cotton in the mass. This had been stored in a room 15 by 30 feet. It had been forked over from the center and the sides and from end to end of the room three times and the whole mass had been moved once from one room to another.

When our observations began, bulbs were planted in almost every part of the pile, which was at no point more than 4 feet deep, and temperatures were found ranging from 69° to 111°, with the room temperature at 65° F. A sample was drawn from the immediate vicinity of the bulb registering 111° F. and was thereafter kept in a small sack in a dry place until the seeds were picked from it by hand for the germination test. Two tests of this seed showed a germination of 13 and 5 per cent, respectively.

On October 7 the Southern Cotton Oil Co.'s mill at Bennettsville was shoveling over a pile of about 100 tons of seed the previous history of which is unknown, but it was a little above blood heat in several spots at the time. This seed was rebulked in the seed house, and two bulbs were planted in the mass as it was moved and then covered with some 10 tons of seed. The first record of temperature made on October 9 showed 87.25° and 82.5° F. for the two bulbs. On October 11 the readings were 89° and 86.5°, respectively; on October 21, 127° and 133° F.

The manager of the oil mill considered the seed in a dangerous condition at this heat and immediately began its manufacture. More frequent observations were not made, because the oil mill was located at a considerable distance from the storage house, which made daily records at both places impracticable. On October 21 a sample of seed was drawn from the portion of the pile registering 133° F. Two tests have been made without germinating a single seed from this lot.

The most important results of these tests are those developed from sample 2. This cotton had not apparently been injured in any way by the heating to which it had been subjected; it had not been wet when picked or when stored. It contained, of course, a larger proportion of freshly opened bolls and a smaller proportion of thoroughly dried-out bolls than the cotton which was picked a week later. Its behavior was entirely different, and though it was closely watched and an unusual amount of labor expended in frequently forking it over and stirring it about, yet the planting value of its seed was practically destroyed at certain points in the mass within the first 10 days of storage. Our tests of freshly picked samples of this same cotton showed from 43 to 64 per cent of germination. Whether a cotton of stronger germinating power would have withstood the same degree of heating in storage with less damage is an open question.

The practical point to be observed is that cotton from which planting seed is to be saved must be so thoroughly dried out before bulking or must be spread out in such thin layers as to prevent any noticeable development of heat if the germination of the seed is not to be affected. These observations have not covered a suffi-

ciently wide range of conditions to enable us to establish any definite degree of temperature at which germination begins to suffer, but the observations made indicate very clearly that it is not safe to plant any seed which has been subjected to even the slightest heating and fermentation, and that the planting value of the seed may be entirely destroyed by a sweating and curing-out process, which does not injure the lint to any perceptible extent. The practice of saving seed for planting from late pickings is due, no doubt, to the greater tendency of early pickings to heat.

When this particular pile of cotton was forked over to bin B, on the morning when the maximum temperature of 111° F. was discovered, it was thoroughly mixed and no portion of the pile again developed a temperature of as much as 90° F. This would indicate that the heating which had reduced germination to about 10 per cent was only a transient condition incident to the curing of the pile.

CONCLUSIONS.

As a result of this season's observations the conclusion is reached that similar data must be secured on earlier pickings and on cotton picked more promptly after rains, as well as upon cotton stored in larger and smaller piles and in both moist and dry climates, before any definite rules can be laid down concerning temperatures at which injury to seed or fiber takes place. An interesting question arises as to the effect on the milling and feeding value of seed which has been so heated as to prevent germination. Experiments and observations on a number of these points are planned for the coming season. The facts here recorded are believed to be of value as establishing certain known points of damage to germination, and also as showing the perfect safety with which considerable bodies of mature seed cotton can be stored if care is taken to have the cotton free from exterior moisture when stored.

EGYPTIAN COTTON CULTURE IN THE SOUTHWEST.[1]

By Carl S. Scofield, *Agriculturist in Charge of Western Irrigation Agriculture.*

INTRODUCTION.

Since 1902 the Bureau of Plant Industry has been experimenting with Egyptian cotton in the irrigated sections of the Southwest. At the close of the season of 1911 these experiments had reached a stage which seemed to justify the trial of this crop on a small scale by farmers in the Salt River Valley in Arizona and in Imperial County, Cal.

In the spring of 1912 a supply of seed was distributed by the Department of Agriculture for planting by a number of farmers. Most of the seed so distributed was of the Yuma variety, a new type developed in Arizona as a result of careful selection which had been carried on for several seasons. The investigations and experiments made in connection with the breeding and acclimatization have been reported in numerous publications of the Bureau of Plant Industry. The seed distributed in 1912 was entirely free from contamination with the degenerate type known as Hindi cotton, which infests practically all of the cotton grown in Egypt. This seed was distributed to about 75 farmers, and about 530 acres were planted in the spring of 1912. The location of these farmers and the acreage in each locality were as follows: In the Salt River Valley, 32 farmers planted 303 acres, besides 29.5 acres planted on the Indian reservations; in the Colorado River Valley north of Yuma, Ariz. (vicinity of Bard, Cal.), 19 farmers planted 44 acres; in the Imperial Valley, Cal., 25 farmers planted 122 acres. In addition to this acreage in the Imperial Valley, there were 20 boys who planted one-half acre each under the direction of Mr. Walter E. Packard, of the California Agricultural Experiment Station, cooperating with the Bureau of Plant Industry. Near Hechicera, Mexico, south of the Imperial Valley, there was one field of 30 acres.

[1] Issued Apr. 26, 1913.

The work of the Bureau of Plant Industry in connection with establishing the Egyptian cotton industry in the Southwest is conducted under the direction of a committee composed of Messrs. C. S. Scofield, C. J. Brand, O. F. Cook, T. H. Kearney, and W. T. Swingle.

These experimental plantings by farmers were made under the supervision of Mr. Argyle McLachlan and Mr. E. W. Hudson, both of the Bureau of Plant Industry, Mr. Hudson devoting his attention chiefly to the work in the Salt River Valley.

ACREAGE AND YIELDS.

Owing to various causes, a portion of the acreage planted to Egyptian cotton failed to produce a crop. Among these causes was the lack of irrigation water for some of the fields, while the soil in other fields was too salty, and in one section high ground water, resulting from a flood in the Colorado River, killed the crop in midsummer. About 480 acres came through the season to harvest. From this acreage 375 bales of about 500 pounds each were finally picked and ginned. Of the total number of bales 262 were ginned in the Salt River Valley, 17 in the vicinity of Bard, Cal., and 96 in the Imperial Valley. These figures do not include 24 bales produced on the experiment farms at Sacaton, Ariz., and Bard, Cal.

The yields from different fields varied greatly. Many of the farmers who planted cotton were not familiar with the requirements of the crop, and some fields were given very little attention after planting. The average yield of lint per acre, determined from the total quantity of lint known to have been picked and baled and the total number of acres upon which this cotton was produced, was approximately 400 pounds. The acreage upon which this computation is based included, however, much land on which the crop was very light.

A number of fields were measured during the season, and records were kept of the crop harvested. The yields determined from fields in the Salt River Valley are given in Table I.

TABLE I.— *Yields of ginned cotton from certain measured fields of Egyptian cotton grown by farmers in the Salt River Valley in 1912.*

Size of field.	Yield of fiber.	
	Total.	Average per acre.
Acres.	*Pounds.*	*Pounds.*
3.38	2,527	747
5.32	3,872	729
5.35	3,818	714
1.42	994	700
4.75	3,245	683
15.25	10,180	667
10.35	5,937	573
2.89	1,461	506
1.62	794	490
13.45	6,558	488

The yields of cotton shown in Table I vary from slightly less than 1 bale per acre to nearly 1½ bales per acre. While these yields were

much above the average for the entire acreage devoted to the crop, they are sufficient in number to indicate what may be expected by the better farmers on rich land which had previously produced alfalfa, as was the case with most of the yields reported upon.

Two of the yields reported in Table I were those obtained by Pima Indian farmers on the Sacaton Reservation. One of these Indians made a crop of 994 pounds and the other 794 pounds from their fields of about 1½ acres each.

TABLE II.—*Yields of ginned cotton from certain measured fields of Egyptian cotton grown by farmers in the Imperial Valley, Cal., in 1912.*

Size of field.	Yield of fiber.	
	Total.	Average per acre.
Acres.	*Pounds.*	*Pounds.*
11.00	6,105	555
4.76	2,537	533
1.32	620	470
5.00	2,000	400
5.09	2,015	396

The yields from fields in the Imperial Valley as shown in Table II range much lower than those from the Salt River Valley reported in Table I. The lower yields were due chiefly to the less careful preparation of the land and handling of the crop by farmers in the Imperial Valley rather than to any essential difference in natural conditions. This is proved by the fact that some of the boys mentioned obtained yields from their half-acre fields approximating Salt River Valley figures.

The results of the past summer indicate in a very striking manner the importance of thorough preparation of the land before planting and the need of careful attention to the proper cultivation, irrigation, and thinning of the crop during the early stages of growth in order to secure good yields. It is also clear that while profitable crops of Egyptian cotton may be produced on new land or following grain or a previous crop of cotton, the best results are to be had where cotton follows alfalfa. And, while the evidence is not absolutely conclusive, it seems reasonably certain that cotton should not follow sorghum or milo, which crops appear to have a depressing effect on the following cotton crop.

CHARACTER AND VALUE OF THE CROP.

With but few exceptions, the cotton was picked carefully and the seed cotton as delivered at the gins was clean and free from trash. This made it possible to turn out a high grade of lint. The bales were well packed to a density of from 15 to 20 pounds per cubic foot, and they were well wrapped with burlap bagging. The average tare, including bagging and ties, was about 14 pounds per bale. (Fig. 1.)

In quality—that is, in length and strength of staple—the crop was very uniform and satisfactory. Some of the lint stapled only $1\frac{3}{8}$ inches, but the bulk of it was fully $1\frac{7}{16}$ inches long and some was slightly over $1\frac{1}{2}$ inches long. While the entire crop has not yet been sold, the prices for the sales so far reported have been approximately 21 cents per pound, net weight, delivered on the cars at the shipping point. These prices are said to have been based on the sale of the crop at 23 cents per pound at New England points, the margin of 2 cents being required to pay the charges for freight, brokerage, and other marketing expenses.

FIG. 1.—Bales of Egyptian cotton at Mesa, Ariz., from the crop of 1912. The bales are completely covered with a light-weight yet strong grade of burlap.

A small portion of the cotton was of low grade, due to careless picking, or was of comparatively poor quality, due to bad conditions in the fields. This cotton brought a somewhat lower price. The crop from some fields had to be shipped to assembling points to be made up into carload lots, which increased the cost of transportation. However, the bulk of the crop has brought the producer about 21 cents per pound at his shipping point, which, considering the yields previously mentioned, is a satisfactory return.

In a few cases the grower sold his crop in the seed; that is, unginned. In this condition it brought $4\frac{3}{4}$ and 5 cents per pound, and at this price the purchaser was able to pay the cost of ginning and baling and to sell the fiber at 21 cents with a safe margin of profit.

From the results of the ginning records made during the season it appears that a little less than 1,800 pounds of seed cotton of the Yuma variety may be expected to give a 500-pound bale of fiber. There have been marked variations in this respect. The observed range of percentage in fiber from seed cotton has been from 25.2 per cent to 31.7 per cent, with an average of about 28 per cent for the entire crop.

In the Salt River Valley a large proportion of the seed resulting from the 1912 crop has been reserved or sold for planting in 1913. The price when sold for this purpose has been from 1½ to 3 cents per pound. In the Imperial Valley most of the seed was sold to an oil mill at the rate of $15 per ton. Some of the seed has been used for feed, and when so used was considered as worth about 1 cent per pound. The seed is a factor of appreciable importance in the crop return. Even when sold to the oil mill it brings a sufficient return to pay more than the cost of ginning and baling the crop.

COST OF PRODUCTION.

The cost of producing Egyptian cotton, exclusive of harvesting the crop, varied between wide limits. It has been possible in a few cases to ascertain the cost of production; that is, the cost of labor and irrigation water, but not including interest on the land investment. On the larger fields, where teams and machinery could be used to advantage, this cost, exclusive of picking, ginning, and baling, ranged from $11 to $16 per acre. One of the important factors in the cost of production was the preparation of the land. Where it was necessary to subdue a tough sod of alfalfa and Bermuda grass the cost was high. This was particularly the case where the work early in the season was not done thoroughly. The best results in crop yields as well as the greatest economy of labor were secured where the early tillage was thorough and the land was brought into the best possible tilth before the crop was planted.

The cost of picking Egyptian cotton was no less variable than the cost of production. On the irrigated land of the Southwest the cotton plants grow very large, with many branches. When loaded with a heavy crop the plants bend over and become so entangled that it is difficult to get through the field. (Fig. 2.) Where the acreages were small for each family, no cash outlay for picking was needed. In the Imperial Valley, where labor was scarce and there was a lively demand for pickers in adjacent fields of short-staple cotton, it was sometimes found necessary to pay from 3 to 3½ cents per pound for picking. In the Salt River Valley, on the other hand, the labor supply was adequate and the bulk of the crop was picked for 2 cents per pound. These prices, of course, refer to the seed cotton.

It was found that good pickers averaged about 100 pounds of seed cotton per day where the crop was good. In several cases good

pickers brought in from 125 to 150 pounds per day when conditions were especially favorable. Pickers may be expected to average from 70 to 100 pounds per day throughout the season, and when working at this rate the seed cotton should be delivered very clean and free from trash. On the basis of these results it is estimated that one picker will be required for each two or three acres of cotton. The picking season in 1912 began about the middle of September and closed early in February, 1913, though for the best results it should have closed a month earlier, as the late-picked cotton was generally of poor quality.

FIG. 2.—A field of Egyptian cotton in Arizona, showing the large size of the plants, which makes picking more expensive than is the case with Upland cotton.

The ginning and baling of Egyptian cotton is more expensive than the similar operations for Upland cotton. From the results of last year's experiment it is not possible to estimate with accuracy just what the cost will be when a larger crop is available. The arrangements for ginning the first crop were made more with a view to economy in purchase than in operation, and much of the work was done at a disadvantage. From the data obtained it appears that the ginning and baling cost last year from $6 to $10 per bale. The roller gin used for the Egyptian cotton was the same as the one generally used in the Sea Island district of South Carolina and Georgia.

The turnout averaged about 1 bale per day from each gin, though under favorable conditions it was possible to gin 1½ bales with each machine.

The cost of producing an acre of Egyptian cotton, estimating a yield of 1,800 pounds of seed cotton per acre, may be summarized as follows: Seed, tillage, and irrigation, $15; picking, $36; ginning and baling, $10; making a total cost of $61 per acre, exclusive of interest on land investment. It should be kept in mind that these figures are merely approximations. The actual costs will be found to vary between wide limits, both above and below these figures.

CONCLUSIONS DRAWN FROM THE SEASON'S WORK.

The results of the season's work on Egyptian cotton in the Southwest appear to warrant a material increase in the acreage devoted to that crop. It would appear that farmers, particularly in the Salt River Valley, will be justified in a further trial of the crop and on a much larger scale. The prices paid for the crop were comparable with those paid for imported Egyptian cotton during the same period of sale. It has been demonstrated by repeated experiments that Egyptian cotton of excellent uniformity and good length and strength of staple can be produced on the irrigated lands of southwestern Arizona and southeastern California. The production of Egyptian cotton in larger quantities should result in attracting the attention of users of that staple to this new producing region, and consequently lead to a more advantageous marketing of the crop.

The crop is one which fits admirably into the best rotation system for these southwestern irrigated lands. When cotton is alternated with alfalfa the results are beneficial to both crops and to the productivity of the soil. Alfalfa is and probably will remain the most important single crop of these irrigated lands, but the maximum production of this crop is to be expected only where it is grown in rotation with some cultivated crop, such as cotton, which permits the killing out of the Bermuda grass, Johnson grass, and other weeds which invade the alfalfa fields and after a time greatly reduce their productivity.

For the best results in maintaining a high quality of Egyptian cotton on these irrigated lands, it will be necessary to maintain a supply of pure and carefully selected seed. The variety which has been used by farmers during the past season is the result of several years of selecting and testing. The experiments which resulted in the production of this variety are being continued, and other and better varieties may reasonably be expected in the future.

Meanwhile, it is of the utmost importance that the seed used for planting by the farmers shall be uncontaminated by cross-pollination

with other varieties or types of cotton. In order to insure this, it is very desirable that in each community only one variety or class of cotton be grown. This is important, not only from the standpoint of keeping the seed supply pure, but also in order to avoid confusion in the minds of cotton buyers with reference to the class of cotton produced in each section. It is possible, for instance, for the farmers of the Salt River Valley, by cooperating in maintaining the purity and quality of their seed supply and in carefully handling and harvesting their crops, to develop a reputation for their cotton which will be a commercial asset of great value. Such a result would be impossible if several different kinds of cotton were grown in the same region.

In the Imperial Valley the size of the land holdings and the labor supply are such that it appears desirable for the farmers of that community to specialize on a big-bolled and hence easily picked variety of long-staple Upland cotton, such as Durango, rather than on Egyptian. In the Salt River Valley, however, conditions appear to be more favorable for the development of a cotton industry on the basis of the Egyptian type. There the land holdings are generally smaller, the labor supply more abundant, and it has been demonstrated that fiber of very high quality and value can be produced.

There remain several important steps to be taken by the cotton growers of the Salt River Valley before the cotton industry can be said to be well established. Larger and more efficient ginning plants must be established, and satisfactory arrangements must be made for the disposal of the seed, either by erecting an oil mill in the valley or by marketing the seed at some outside point. The cotton growers should definitely associate themselves for the purpose of establishing and maintaining market grades of cotton which shall be uniform throughout the season and shall fluctuate as little as possible from one season to another. They should also make arrangements for storing the cotton in warehouses after it has been ginned and baled, under circumstances which will make it possible to borrow money upon it until it can be marketed to advantage. It is very undesirable to be compelled to sell cotton as soon as the crop is ginned in order to raise money to pay for the cost of production.

It is also extremely important that every precaution be taken to avoid the introduction of the boll weevil and other noxious insects into the cotton-producing sections. It is by no means certain that the boll weevil will thrive under irrigated conditions in the Southwest, but the risk is too great to excuse negligence in this matter. Finally, it is of the utmost importance to the future of the Egyptian cotton industry in the Southwest that the farmers take up very seriously the question of maintaining an adequate supply of pure seed of high-yielding and uniform varieties.